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Final Year Project Report ☒

Masters ☐

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# **IMPLEMENTING WEB CUSTOMIZATION OF 3D INTERIOR HOME DESIGN**

ELVIS YOON YU JING

This project is submitted  
in partial fulfillment of the requirements for a  
Bachelor of Science with Honours  
(Cognitive Science)

Faculty of Cognitive Sciences and Human Development  
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The project entitled 'Implementing Web Customization of 3D Interior Home Design' was prepared by Elvis Yoon Yu Jing and submitted to the Faculty of Cognitive Sciences and Human Development in partial fulfillment of the requirements for a Bachelor of Science with Honours (Cognitive Science)

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## **ABSTRACT**

It is common nowadays for consumers to customize their products according to their preferences before purchasing. However, home customization is currently rarely adopted in Malaysia. Custom homes are known as unique houses that are built for specific customers according to their own preferences. These specially built houses allow users to have control over the layout and design of their house so that each and every unit of the house will be different depending on the client's wants and needs. This is to ensure that the user's needs are fulfilled and they will be satisfied with their future house. All this would increase customer satisfaction and improve usability of the new house. Therefore, this project endeavors to implement a website where people can easily customize the internal layout and design of their house using a web application. To implement this system, Unity3D is used to create the application. Upon completion, the system will be evaluated for its usability through qualitative study.

*Keywords: Unity3D, Home Customization, Architectural Walkthrough, Housing Interior*

## **ABSTRAK**

Pada masa kini pengubahsuaian produk mengikut cita rasa pengguna sendiri sebelum pembelian merupakan sesuatu perkara yang biasa. Walau bagaimanapun, pengubahsuaian rumah sebelum pembelian masih jarang dipraktikan di Malaysia. Rumah yang telah diubahsuaikan dikenali sebagai sebuah rumah yang unik yang dibina untuk pelanggan tertentu mengikut pilihan mereka sendiri. Rumah-rumah ini dibina secara khas dan pengguna mempunyai kawalan atas susun atur dan reka bentuk rumah mereka serta setiap unit rumah yang dibina akan berbeza mengikut kehendak dan keperluan pembeli rumah. Ini adalah untuk memastikan bahawa keperluan pengguna dipenuhi dan mereka akan berpuas hati dengan rumah masa depan mereka. Kesemua ini dapat meningkatkan kepuasan pembeli rumah dan menambahbaikkan kebolegunaan rumah baru tersebut. Oleh sedemikian, projek ini berusaha untuk melaksanakan sebuah laman web di mana orang ramai boleh mengubahsuaikan susun atur dalaman dan reka bentuk rumah dengan menggunakan aplikasi web. Untuk melaksanakan sistem ini, Unity3 telah digunakan. Pada akhir projek ini, sistem yang dibina akan dinilai melalui kajian kualitatif.

*Kata-kata kunci: Unity3D, Pengubahsuaian Rumah, Perjalanan Maya Arkitektural, Ruang Dalaman Rumah*

# **CHAPTER ONE**

## **INTRODUCTION**

### **Overview**

Today, various products can be easily bought online according to the customer's own preferences by just a few clicks via the internet. Furthermore, the products bought online nowadays often provide customers with the option of customizing their products. E-commerce websites such as alibaba.com, Amazon, Ebay and Zalora are a few companies that have adopted this kind of service.

Housing development too has undergone great changes. However, customizing your personal house online using 3D software is still considered a rarity in Malaysia. Hence, this project will endeavor to help people customize the interior of their own homes just by the help of the internet.

This chapter will include the introductory chapter, the background of the study, problem statements, objectives, scope of the project, value of the research, significance of the development, structure of the project, conceptual framework and the limitations of this project.

### **Background**

Custom homes are unique houses that are built for specific customers according to their own preferences. Custom homes allow users to have control over the layout and design of their house so that each and every unit of the house will be different depending on the client's wants and needs. In fact, the housing market in Korea has proved that in order to remain competitive, customization of homes under customer-oriented market conditions is unavoidable (Shin, An, Cho, Kim, & Kang, 2008). Even though cost- efficient high rise apartments can be widely found

in urban areas, but they pose a downside in that the design of each unit can appear the same and might not meet different customer needs (Lee & Ha, 2013). Therefore, this project aims to create a website which enables clients to design their own home or apartments before sending in their design online to receive a price quotation for their modified home.

According to Chein and Shih (2000), apartments in Taiwan are sold before construction, and hence customers are given the option to customize their own unit beforehand. When customer's needs are taken into consideration throughout the construction process, their active role would drive the development towards a more user-centered apartment unit. Thus, making customizing homes a reality will provide a solution towards dull, repetitive urban housing environments (Lee & Ha, 2013).

In a research done by Ozaki (2003), has stated that customer satisfaction is of utmost importance in the service industry especially in the house building industry. Furthermore, Ozaki (2003) has also found that there has been a progress driven by the government in the United Kingdom to improve customer satisfaction in this industry too. As a result, customers are given the choice to tailor their own home individually so that they will be satisfied with what they have paid to get.

## **Problem Statement**

Nowadays, looking for a home that suits everybody wants and need can prove to be quite a challenge as different people has different preferences. Furthermore, it is a well known problem that users are not playing an active role in their house design process, or at least its interior design (Cheng & Lee, 2005).

This problem is especially apparent in apartment units because throughout the whole building, the interior design of the apartment unit is usually the same. The only difference is the number of rooms and the size of the living room of each unit. Hence, customers will face problems if they wanted some modifications because they would need to hire an interior designer to make the changes that they want for their apartment unit.

The problem arises when customers need to spend extra time to hire interior designers to do their job after the whole apartment has finished construction. This is time consuming and the buyers have to wait another few weeks or even months to move into their new home.

Today, the client's usual practice is to discuss with sales agents or hire interior designers themselves in order to customize their own home (Zhu, 2000). Clients do not have the full authority and flexibility to modify their own property.

## **Objectives**

The objective of the project is divided into two categories. These categories are general objective and specific objectives.

### **General Objective**

The general objective of this project is to develop a website where people can easily customize the internal layout and design of their house using the internet. Customers can easily make changes to the wall paint and objects of the housing interior.

## **Specific Objectives**

The specific objectives are:

- (i) To design and develop a website that enables users to customize their own house interior using Unity software.
- (ii) To evaluate the effectiveness of the online home customization website to the users.

## **Scope of the Project**

The scope of this project is to develop a website that enables users to customize the layout and design of their own houses by using the Unity software. The website will enable users to select from variety wall paint and even the objects in the room can also be modified.

## **Significance of the Development**

The main significance of this study is to help clients to customize the interior of their own house, be it layout or design. Hence, this project aims to develop a website that users can choose from a variety of house type that will be constructed by a particular developer and make interior customization based on their own preferences. This is to ensure that the user's needs are fulfilled and they will be satisfied with their future house. All this would increase customer satisfaction and improve usability of the new house.

## **Structure of the Project**

This project consists of 5 chapters. Each of the five chapters in this research will consecutively discuss about the heart of this study, literatures related to it, system development

and also the evaluation of this whole project. The following five chapters consist of introduction, literature review, research methodology, system development, and evaluation.

Chapter 1 focuses on introduction, background, problem statement, objectives, scope of project, significance of development, structure of the project, conceptual framework and conclusion.

Chapter 2 looks into the literature review of this project. Similar researches will be discussed and will be used as the foundation of this study. The uses of the Unity software will be further looked into in this chapter.

Chapter 3 is the research methodology of this project. The main intention of this chapter is to introduce to the user the overall concept of how the system works. It contains the specifications needed to produce this system, system flow, research design and system architecture.

Chapter 4 deals with the development of this project. It consists of coding, and the implementation of this system will be explained by using screenshots from the project.

Chapter 5 will include the results and evaluation of this whole project. Participants' suggestion will be taken into consideration to make improvements. Summarize the overall project. A conclusion will be made and future works will be discussed.

## **Summary**

This chapter has discussed introduction, background, problem statement, objectives, scope of project, significance of development, structure of the project, conceptual framework and conclusion. In the following chapter, literature review of this project will be discussed.



## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **Overview**

This chapter will present an overview of the literatures related to this research. The types of engine used to create 3D building models and the applications of gaming engines in architectures will also be included in the discussion. Technical aspects that will be needed for this project's development will also be discussed. These approaches will be discussed in order to help the users to understand the whole project better.

#### **Custom-made Homes**

According to Claiborne and Ozanne (1990), custom-made products are co-created by a producer and a consumer. The consumer would communicate either implicitly or explicitly with the producer prior to the manufacturing of the product, which would thus shape the end product.

Therefore, in order for a product to be custom-made, both the consumer and the producer must cooperate. In fact, the consumer or the producer may be an individual or a group working hand in hand together to accomplish a specific product. The producer's influence can range from directing the process of creation to merely carrying out the consumer's preferences. The consumer, on the other hand, can influence the product by specifying the design, size, materials, time and so forth (Claiborne & Ozanne, 1990). As far as this project is concerned, when a consumer works with an architect to create the layout of the house before the actual house is built, only then this would be referred to as a custom-made product.

By offering consumers a customized market, it has the ability to empower them the very thing they can exercise freely, which is the power to choose (Marketing News, 2006). Therefore, by offering customization, consumers can get exactly what they want and companies will be able

to charge for premium quality, and at the same time be rewarded with customer loyalty (Valenzuela, Dhar, & Zettelmeyer, 2009).

### **Significance of Home Customization**

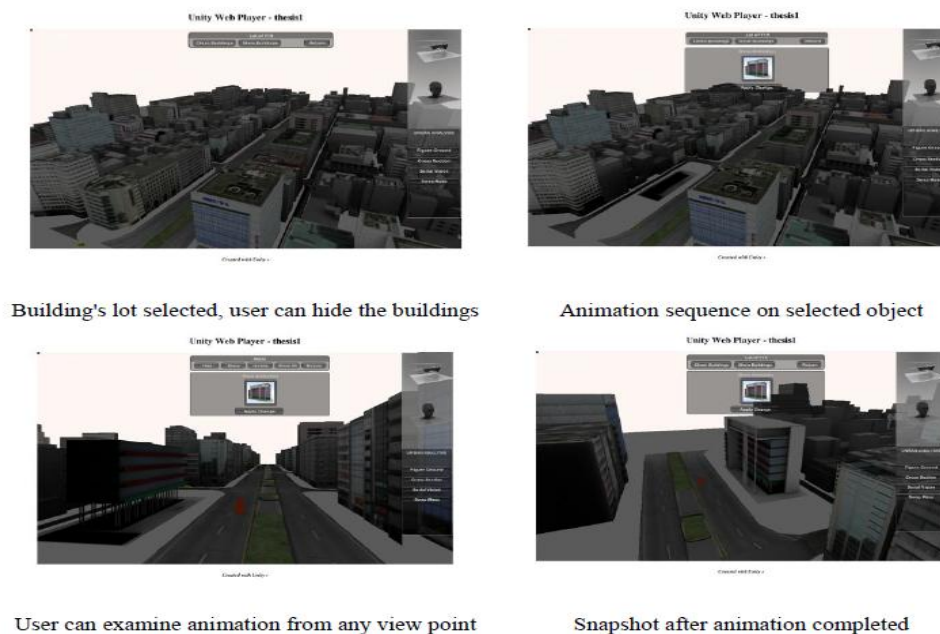
One of the most significant achievements of customizing the consumer's own home is that people are given the opportunity to encode meaning into them. Consumers are not forced to accept any cultural symbols encoded by the architect or developer of the house. According to Claiborne and Ozanne (1990), consumers would customize their home based on their life experiences, in other words, home actually mirrors the cultural background and life experiences that shape the consumers themselves.

Based on the study conducted by Clairborne and Ozanne (1990), customization also represents a way for consumers to express themselves. Besides that, consumption choices pervades every aspect of an individual's life, thus providing consumers an option for home customization would also represent an opportunity for them to extend their cultural and personal meaning into the home that they personally want. Custom-made products are in fact by the user and for the user on a personal level.

Clairborne and Ozanne (1990) also found that participants of their research who have actually lived in their own customized home indeed experienced unexpected changes in their lives that had taken place because of their new home. The meaning that they experience is personal, experiential, and symbolic. People construct their homes as they would wish to construct their lives (Clairborne & Ozanne, 1990). Henceforth, the idea of letting consumers structure their home environment to reflect the way they would like to live would be very much applicable to home and condominium buyers.

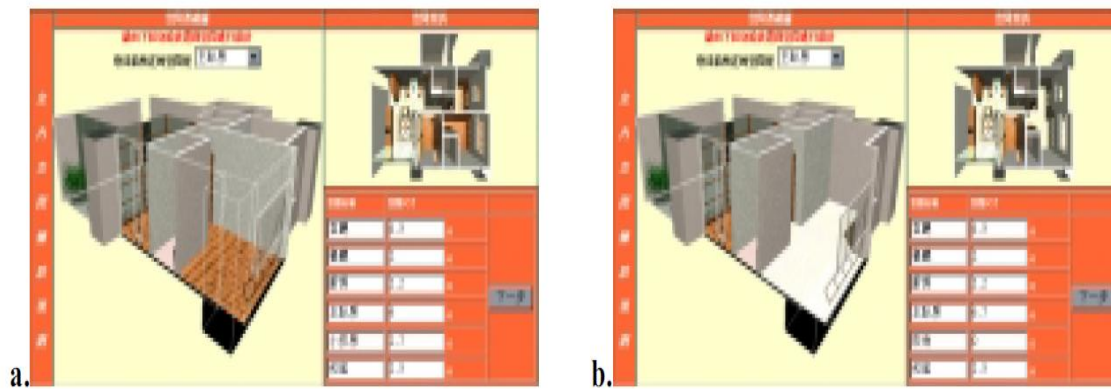
An individual can create meaning by creating a product whereas the product can shape the consumer. Clairborne & Ozanne (1990), refer to this as the reciprocal co-creation process where the experience of customization affects both the product and the consumer itself.

**Using *Unity* Game Engine in Urban Design Study.** Indraprastha and Shinozaki (2009) have conducted a study to design an urban landscape by using the Unity engine. The trend of architectural visualization nowadays has reached the point of depicting the real world as real as possible using computer generated images, if possible, even hyper-realistic. Unity engine is used because it is able to provide interactive functions and also ease of use in the context of geometry data input and output. CAD (Computer-aided design) may have been left behind by other technologies. However, game engine technology which offers more productive and effective aid for design is still uncultivated.



*Figure 1.* Snapshots of the Unity Web Player visualizing urban landscape.

**Web Environment Supported Apartment Customization in Taiwan.** According to a research done by Chien and Shih (2000), apartments in Taiwan provide buyers with the option to customize their own units until contraction takes place. However, an abundant of information exchange has to be documented between related agencies for each apartment unit. Once the purchase has been made, buyers can easily customize the interior design of their own unit. Changes can be made to the layout, finishes and also fixtures. The customization has become a very unique form of user participation of 3D home design on the web in Taiwan.



*Figure 2.* Users are given the option to make layout selection on the web.

### **Classes of Game Engines Available**

As a matter of fact game engines are myriad and there is a wide range of categories that users can choose from for development. Most of the gaming engines can be broken down according to their cost. However, there are times where a gap between the cost and features may exist. Thus choosing an appropriate gaming engine for development is very crucial.

At the very top of the game engine pyramid, would be A-listed software with top notch rendering techniques. These high performance engines have the ability to render large amounts of polygons using the latest rendering techniques and thus providing the most realistic graphics on the market nowadays. In most cases, engines like these have the capability to permit visual

programming, rapid prototyping, and provide numerous interface for the users to interact with the engine without the need to code (Birch, 2009). These engines of course come at a very high price given its functionality and usability. Today, the more well known engines would be CryTek and also Unreal.

Stuck between the high-end and low-end game engines consist of a huge variety of commercial engines. They are caught in the middle, without being too expensive and also helping users achieve moderate performance needs. Usually, game engines like these are often tailored to a specific need. Figure 2 depicts the functions of the game engine correlating to its best performance. However, most of these engines provide editing system that helps users to achieve what they want. In fact, it is even more user centered since they have less features to learn (Birch, 2009).

Table 1

*Game engines and its best function*

Quest3d Suite	
	<i>Architectural visualization</i>
Unity3d Engine	
	<i>Web and Iphone development capabilities</i>

At the back-end of this spectrum are mostly open source engines like Orgre3d, Axiom, Crystal Space and Irrlicht (Birch, 2009). Open source engines enable users to freely make changes to the engine itself because access to its own source code is readily available. Yet, none of these engines provide users with a supported editing system which users will need to rely on pure coding to build a prototype (Birch, 2009). But then again, open source engine's benefit is that it enables user to have complete control over the rendering pipeline (Birch, 2009).

Given the availability of game engines to choose from, it is often up to the user himself to look for an engine that works best to accomplish his task, therefore subjective to the user.

## Game engines

This part of the research will be looking into the type of game engine along with its pros and cons in dealing with its application and usability. At this point of the study, four game engines will be discussed, mainly: Unity3d, Torque, C4 Engine and 3D Game Studio.

**Unity3D.** *Unity* is currently the most balanced game engine to develop web deployable content. It is cost effective and readily available to any user (Schroeder, 2011). *Unity* has very basic CPU requirements that can easily cater for all kinds of computer even those which were manufactured few years back. Compared to other game engines, *Unity* is considered more flexible than others because it can easily run on Mac and Windows OS (Unity System Requirments, n.d.).

*Unity* is a partially free game engine. Users can easily download them on the *Unity* website and start creating whatever contents that the user desire. Furthermore, developers can use *Unity* to create and sell any contents that they have made. But the according to the end user license agreement, a company must purchase a *Unity Pro* license if the profits made by the company exceeds \$100,000 per annum (Unity EULA, 2013).

One of the core advantage of *Unity* for this research is it offers plug-ins to easily create web deployable content. Furthermore, *Unity* allows user to install a plug-in on their web browser to navigate through the web content online. As for the case of this research, custom home buyers can also use *Unity* to access their desired home online without having to travel to the actual site (Schroeder, 2011).

**Torque3D.** *Torque* is an open source game engine created by GarageGames. This engine comes with a Software Development Kit (SDK) which helps users to save time and increase efficiency in building a rendering system (Torque, 2010). In fact, for users who intend to

visualize architectural models, *Torque* combines both interior and outdoor design modules in one software package (Torque, 2010). *Torque* is written in C++ language and since it is an open source engine, users can always access to the inner functions of the code to make customization that suits their needs. Also, *Torque* supports Windows and browser-based web deployment too (Torque, 2010).

**C4 Engine.** *C4 Engine* is developed by Terathon Software. This is a robust engine which has the capability to support a wide variety of platforms such as Windows, Mac OS X, Linux and Playstation 4 (C4 Engine, 2014). In fact, many schools around the world has adopted *C4 Engine* in connection to games-oriented curriculum including MIT, Gerogia Tech, University of Alberta and many more (C4 Engine, 2014). This engine is at the fourth place out of the four most reviewed gaming engines on the market currently (DevMaster.net, 2007). These reviews are mostly from professional developers who use gaming engine for commercial purposes.

**3D Game Studio.** *3D Game Studio* claims itself to be the fastest authoring system for interactive 2D and 3D applications. It supports the development of simulations, video games and also other software programs. This engine runs on three programming languages, mainly C, C++ and Delphi. However, *3D Game Studio* can only support Windows platform unlike its counterparts which can also support Mac OS and also Linux OS. The platforms that this gaming engine supports is quite low and the system is not free for downloads.